

10-12) pertain to the well known Viterbi algorithm which is not the subject of the present invention. The third reference (p.14, lns. 14-15) refers to a partial Ungerboeck metric that is disclosed in a prior U.S. patent. The present invention describes, *inter alia*, a method for reducing the number of multiplications needed to implement a demodulator that uses the partial Ungerboeck metric. Thus, the present invention does not manipulate the partial Ungerboeck metric, rather it operates on a partial Ungerboeck metric. The partial Ungerboeck metric itself is not altered by the present invention. (see p. 14, lns. 11-15).

### 35 USC 112 Rejection

The Examiner has rejected claim 3 under 35 USC 112, 2<sup>nd</sup> paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter because the term "s-parameter" has not been defined in the claims. The term s-parameter is clearly defined in the specification at p. 13, lns. 5-10. Applicant does not believe that an actual definition of the term s-parameter is required in the claims. Rather, the use of the term s-parameter in claim 3 should be read in light of its description in the specification. Since there is a clear definition of s-parameter in the specification, it is applicant's belief that claim 3 is not indefinite with respect to the term s-parameter. Therefore, applicant respectfully requests reconsideration and withdrawal of the 35 USC 112, 2<sup>nd</sup> paragraph rejection of claim 3.

### 35 USC 102 & 103 Rejections

The Examiner has cited Kumar as anticipating claims 1-2, 4-7, 9-10, and 12-13 under 35 USC 102(e).

With respect to independent claims 1, 4, 5, 9, and 13, the Examiner asserts that Kumar teaches *a method for determining a branch metric ( col. 31) in a maximum-likelihood sequence-estimation equalizer (fig. 9) which receives at least one antenna signal (fig. 9: input to 201) modulated with M-ary modulation (col. 65: line 67; col. 33: paragraph 8), said method comprising the steps of: pre-computing values equal to a product of a complex number and a hypothetical symbol value (Kumar col. 43 lines 43-45: filter coefficients are convolved by input symbols where convolution inherently means multiplying, storing, and adding); storing said pre-computed values in a product table (Kumar col. 43 lines 43-45: part of convolution; col. 31: lines 25-27 "accumulated"); adding select pre-computed values from said product table to produce a result (Kumar col. 43 lines 43-45: part of convolution; col. 31: lines*

25-27 "accumulated"); and determining said branch metric using said result (Kumar col. 31 : lines 25-27 "accumulated. ..branch metrics ...are compared").

With respect to claim 2, the Examiner asserts that Kumar teaches *the method of claim 1 wherein said complex number corresponds to a channel coefficient* (Kumar col. 43, lines 43-45).

The Examiner has misapplied the Kumar reference to the present invention. The present invention is focused on a reduced complexity MLSE equalizer for M-ary modulated signals. This means that the branch metric to be determined by the present invention pertains to the equalizer on the receive side as used for demodulation. In contrast the branch metric described in Kumar pertains to a decoder in the transmit portion of the system (ECC decoder – see col. 31, lns. 29). Thus, the branch metrics referred to in Kumar are applied to a different function (decoding) in a different portion of an RF system (transmitter) when compared to the present invention that determines a branch metric for an equalizer in the receiver. In addition, the Kumar equalizer cited by the Examiner in Fig. 9 is a linear equalizer (see col. 58, lns. 21-49) of the type that includes a minimum mean square estimate (MMSE), least mean square (LMS), and recursive square estimation (RSE). The equalizer at issue in the present invention is an MLSE non-linear equalizer. Since the Kumar equalizer is linear it cannot be associated with a branch metric. This fundamental difference leads to several misapplications of the Kumar reference to the present invention.

For instance, the step of "pre-computing values equal to a product of a complex number and a hypothetical symbol value" in the present invention is purportedly anticipated by Kumar at col. 43, lns. 43-45. The entire text of the cited passage reads, "In general, the coefficients of the frequency-domain sequence are complex (i.e., having real and imaginary scalar values)." The Examiner has further asserted that "filter coefficients are convolved by input symbols where convolution inherently means multiplying, storing, and adding". While the Examiner has provided an extremely liberal interpretation to the cited passage in Kumar, he has not shown that the values in Kumar are either pre-computed or use a hypothetical symbol value as stated in claim 1 of the present invention. This is because the branch metric calculations of Kumar occur in the transmitter and, by definition, the values used in the multiplication are not hypothetical but already known.

The Examiner further relies on col. 43, lns. 43-45 to teach the storing step. The storing of a product table that is occurring in the present invention provides the ability to look-up the values in the table in later calculations. Indeed, this is the essence of reducing the complexity of the process. Kumar teaches no such step either expressly or implicitly.

Lastly, the Examiners citing of Kumar at col. 31, lns. 25-27 as anticipating the “adding” and “determining” step of claim 1 is also misapplied. Kumar is referring to branch metrics pertaining to decoding (specifically Viterbi decoding) on the transmit side which is completely unrelated to the steps of the present invention which are used to determine or compute a branch metric in an MLSE equalizer on the receive side.

With respect to claim 2 the Examiner re-cites Kumar col. 43, lns. 43-45 as anticipating a complex number corresponding to a channel coefficient. This is incorrect. A channel coefficient is the result of over-the-air transmission. That is, the channel coefficient refers to the transmission medium. Kumar coefficients pertain to the transmission side of the RF system.

Kumar does not anticipate the present invention in any respect. Kumar does not teach determining branch metrics in an MLSE equalizer, pre-computing values using a hypothetical symbol value, storing pre-computed values in a product look-up table, adding select pre-computed values, and determining the branch metric using the result.

Rather, Kumar describes using branch metrics for decoding within a transmitter of a digital audio broadcast FM radio system.

Applicant therefore respectfully requests reconsideration and withdrawal of the 35 USC 102(e) rejection of claims 1-2, 4-7, 9-10, and 12-13. Moreover, since the remaining claims (3, 8, and 11) depend variously from the above claims, the 35 USC 103 rejection of those claims should be withdrawn as well.



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CONCLUSION

For these reasons, and in view of the above, this application is believed to be in condition for allowance and such action is earnestly solicited. However, should there remain unresolved issues that require adverse action, it is respectfully requested that the Examiner telephone Gregory A. Stephens, Applicants' Attorney at 919/462-0454 so that such issues may be resolved as expeditiously as possible.

Respectfully Submitted,

7/26/02  
Date

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Marked up Copy of Amended Claims

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1. (Amended) A method for determining a branch metric in a maximum-likelihood-sequence-estimation equalizer which receives at least one antenna signal modulated with M-ary modulation, said method comprising the steps of:

- pre-computing values equal to a product of a complex number and a hypothetical symbol value;
- storing said pre-computed values in a product look-up table;
- adding select pre-computed values from said product look-up table to produce a result; and
- determining said branch metric using said result.

4. (Amended) A filter in a maximum-likelihood-sequence-estimation equalizer, which demodulates at least one received radio signal modulated with M-ary modulation, for producing a hypothesized received signal sample to be used for determining a branch metric, said filter comprising:

- a memory for storing a product look-up table having pre-computed values equal to a product of a channel tap estimate and a hypothetical symbol value for different iterations; and
- an adder for adding select entries from the product look-up table to produce a hypothesized received sample signal.

13. (Amended) A method for computing a branch metric in a multi-channel maximum-likelihood-sequence-estimation (MLSE) equalizer which demodulates M-ary modulated signals, said method comprising the steps of:

- pre-computing a plurality of possible values for each channel in said multi-channel MLSE to be used in the branch metric computation;
- storing said plurality of possible values for each channel in separate product look-up tables;
- adding select values from said separate product look-up tables; and
- computing said branch metric using said added select values.